CCM-1600 Modular Converter Chassis Group

Illustrated: CCM-1600 Chassis with installed CM-4MD6-A and CM-8MD6-E

The Canary CCM-1600 product group is an economical, long-established, standard and proven solution for connecting today's networks. The group includes: a low profile chassis with sixteen modular card slots and two modular power supply bays; a choice between auto-sensing AC Power Supplies or negative 48 VDC Power supplies; and a variety of mixed Media Conversion card modules for 10-Megabit, Fast, and Gigabit Ethernet.

The CCM-1600 product group has continued to expand with the addition of Single-Fiber, Bi-Directional converters; converters with active CWDM (Coarse Wavelength Division Multiplexing) transceivers; and passive four and eight-channel CWDM Multiplexer / De-Multiplexer modules. Expected soon are the additions of high speed 1.062 Giga-Baud Fibre Channel Fiber-to-Fiber cards, six-port Switch modules with a Gigabit uplink port, a Multi-Rate media card supporting data rates spanning 10 Mbs through 2.7 Gigabits per second, and a 10 Gigabit Fiber-to-Fiber card. These product additions will enable users of the large installed base of CCM-1600s to upgrade and keep their units current as network bandwidth and protocol needs continue to evolve.

Installed success ... proven in the field

CCM-1600
Modular Converter Chassis Group

Features:

- ***16-Slot, unmanaged Rackable Chassis***
- ***Gigabit Ethernet Media Converter modules***
- ***Fast Ethernet Converter modules***
- ***Mixed 10 Mbs Ethernet Converter modules***
- ***Single-Fiber, Bi-Directional Connectors for Gigabit Ethernet and Fast Ethernet Converter modules***
- ***Active CWDM wavelength media converters***
- ***CWDM wavelength Optical Multiplexer / De-Multiplexer modules***

The standard, proven solution for connecting today's networks.

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Product Specifications

Power Supply:
- Modular auto-sensing:
- 115 / 230 VAC, 2.0 / 1.0 Amp, 50 / 60 Hz
- -48 Volt DC

Mechanical:
- Height: 2.8" (7.1 cm)
- Length: 11.2" (28.0 cm)
- Width: 17.4" (43.5 cm)
- Ship Weights:
  Chassis: 8.0 lb (3.6 Kg)
- Single Card: 1.0 lb (0.4 Kg)

Environmental:
- Operating Temp.: 0 to 49ºC
- Storage Temp.: -10 to 66ºC
- Relative Humidity: 5% to 95% non-condensing

Regulatory:
- Designed in compliance with CE, UL, CSA & TUV standards, ANSI X3T1 FC-AL
- IEEE 802.3,u,z,A/B,x
- Class 1 lasers conform to US 21CFR(J), EN 60825-1, UL 1950 and IEC-825

Warranty:
- Five (5) Years, parts and labor

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CCM-1600 Modular Converter Chassis Group

CCM-1600 Media Converter modules connect twisted-pair and fiber optic segments or transition between multi-mode and single-mode media. Canary's CCM converters are used to economically distribute high-speed server capacity to users throughout the network. They are ideal for connecting desktops with low-cost work-group switches and servers – or for high-bandwidth switch-to-switch links.

Canary CCM-1600 Media Converter modules were the first in the industry to speed-up Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology that forwards lost link awareness to all connected hosts.

The pages that follow have the following ordering and other information about Canary CCM-1600 Modular Converter Chassis Group products:

- ***Ordering Information, Active media conversion modules***
  (pgs 4-14)
- ***Ordering Information, CWDM modules***
  (pgs 15-26)
  - *Passive WDM optical Multiplexer/ Demultiplexer modules*
  - *Active conversion modules with transceivers providing ITU-specified CWDM wavelengths*

Appendices
- ***CWDM Overview***
  (pgs 28)
- ***Optical Insertion Loss Calculations***
  (pgs 29-36)
  - *Optical Loss value table*
  - *Optical Loss calculations*

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Subsidiary of RWTÜV Systems GMBH Germany
ISO 9001 : 2000

Canary Communications is an ISO 9001 : 2000 registered company.

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CCM-1600 Chassis

***CCM-1600** – Modular Converter Chassis*

***CCM-12RPS** – Single redundant power supply modules*

This page presents ordering information for the CCM-1600 chassis.

Illustrated: CM-1600 Chassis with CM-4MD6-A.

- Use as rackable or standalone chassis
- Two bays for redundant Power Supplies
- Sixteen card-slots for media conversion modules
- Hot-swappable power supplies and card modules
- Wide variety of protocols and media types supported
- Single-Fiber, Bi-Directional single-mode modules for Fast and Gigabit Ethernet
- Active CWDM transceiver versions launching ITU-specified CWDM transmitter wavelengths
- Passive CWDM Multiplexers (4 & 8 channels) for ITU-specified CWDM transmitter wavelengths
- Choice of Auto-sensing, 115 / 230 VAC Power Supply or negative 48 VDC power supply
- Card features and performance mirror that of Canary's Standalone copper-to-fiber and fiber-to-fiber converters.

Ordering Information

Model Number	Description	Power Source	Shipping Weight
CCM-1600	16-Slot chassis with single AC Power Supply	115/230 VAC Line	8.0 lb (3.6 Kg)
CCM-160048V	16-Slot chassis with single –48 VDC Power Supply	Neg. 48 VDC Source	8.0 lb (3.6 Kg)
CCM-12RPS	Single Redundant AC Power Supply Module	115/230 VAC Line	2.0 lb (0.91 Kg)
CCM-12RPS48V	Single Redundant –48 VDC Power Supply Module	Neg. 48 VDC Source	2.0 lb (0.91 Kg)

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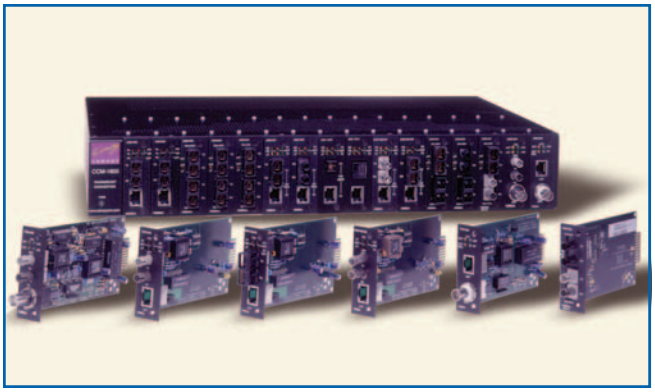
CCM-1600 Active Media Converters



Illustrated: CM-1600 Chassis with modules.

The following sections provide ordering information for active media converter modules with standard fiber optic interfaces.

Included are CCM-1600 Modular converters for the following data rates and protocols:

- Gigabit Ethernet (Standard) UTP-to-Fiber
- Gigabit Ethernet (Standard) Fiber-to-Fiber
- Fast Ethernet (Standard) UTP-to-Fiber
- Fast Ethernet (Standard) Fiber-to-Fiber
- 10 Mbs (UTP-to-Fiber, BNC-to-Fiber, BNC-to-UTP)

Gigabit Ethernet (Standard) UTP-to-Fiber

CCM-10XX – Gigabit Ethernet UTP-to-Fiber: 1000BASE-T to 1000BASE-SX/LX/ZX

Canary's CCM-10XX Gigabit Ethernet Media Converters combine existing 100 meter Category-5(E) UTP and Fiber optic segments to deliver Gigabit data across the network. They are ideal for data intensive backbones in the enterprise or on campus, and can be used to take advantage of low-cost Gigabit capable switches. Canary's Gigabit UTP-to-Fiber Media Converters are used to economically distribute Gigabit Ethernet capacity to user desktops throughout the network as bandwidth demand increases.

Standard CCM-1055 multi-mode Media Converters guarantee minimum transmission distances of 220+ meters over 62.5/125 μm fiber or 500/550+ meters (depending on bandwidth) over 50.0/125 μm fiber. Standard CCM-1031 single-mode models provide transmission distances ranging from 10 to 70 kilometers over 9.0 μm single-mode fiber.

- 1000BASE-T Autonegotiation for Full-duplex and Half-duplex operation with Flow-Control and;
- Switch selectable, Fiber-Port Autonegotiation for common, end-to-end link awareness and Flow-Control, or for independent connection to Gigabit fiber ports on older switches
- Internal Auto-sensing, MDI / MDI-X crossover switch for Network Interface Card or Switch connections
- Transparent to Flow-Control commands such as PAUSE
- A full array of status / diagnostic LEDs
- Additional models include: Single-Fiber Bi-Directional single-mode and versions launching ITU-specified CWDM transmitter wavelengths

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CCM-1055	UTP / MM	-9.5 dBm	-4.0 dBm	-17.0 dBm	7.5 dB	13.0 dB	0.0 dBm	SC	850 ηm	220/550 m
CCM-1056	UTP / MM	-10.0 dBm	-4.0 dBm	-17.0 dBm	7.0 dB	13.0 dB	0.0 dBm	LC	850 ηm	220/550 m
CCM-1055E	UTP / MM	/	/	/	/	/	/	/	/	/
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-1031	UTP / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	SC	1310 ηm	10 Km
CCM-1036	UTP / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	LC	1310 ηm	10 Km
CCM-1031L	UTP / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC	1310 ηm	30 Km
CCM-1031XL	UTP / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC	1550 ηm	50 Km
CCM-1031E43	UTP / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC	1550 ηm	50 Km
CCM-1031E75	UTP / SM	-2.0 dBm	3.0 dBm	-24.0 dBm	22.0 dB	27.0 dB	-3.0 dBm	SC	1550 ηm	70 Km

** NOTE: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or the Gigabit Ethernet, GFT-10XX UTP-to-Fiber Data Sheet for additional information*

More versions of the CCM-10XX series may be found on the Canary web site as they become available

Gigabit Ethernet (Standard) Fiber-to-Fiber Converters

CCM-55XX – Gigabit Ethernet Fiber-to-Fiber: 1000BASE-SX to 1000BASE-SX/LX/ZX

Canary's CCM-55XX Gigabit Ethernet Fiber-to-Fiber Media Converters deliver economical long-range Gigabit data capacity as they link low-cost multi-mode ports with single-mode Fiber optic segments. They are ideal for data intensive backbones in the enterprise or across the campus and can be used to take advantage of low-cost Gigabit capable switches. Canary's Gigabit Fiber-to-Fiber Media Converters are used to economically distribute Gigabit Ethernet capacity to remote user desktops across the network as bandwidth demand increases.

Standard Gigabit CCM-1600 multi-mode ports provide minimum transmission distances of 220+ meters over 62.5/125 μm fiber or 500/550+ meters (depending on bandwidth) over 50.0/125 μm fiber.

- **Simple plug and go installation**
- **Status / Diagnostic LED Indicators**
- **Transparent to Flow-Control commands such as PAUSE**
- **Additional models include: Single-Fiber Bi-Directional single-mode and versions launching ITU-specified CWDM transmitter wavelengths**

Standard Gigabit CCM-1600 models with single-mode ports provide transmission distances ranging from 10 to 70 kilometers over 9.0/125 μm SMF-28 type single-mode fiber.

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
Gigabit converters with standard multi-mode fiber port connectors are designated by (CCM-55XX) or (CCM-56XX) and have similar power and sensitivity specifications.										
CCM-5555**	MM / MM	-9.5 dBm	-4.0 dBm	-17.0 dBm	7.5 dB	13.0 dB	0.0 dBm	SC/SC	850/850	220/550 m ea.
CCM-5656**	MM / MM	-10.0 dBm	-4.0 dBm	-17.0 dBm	7.0 dB	13.0 dB	0.0 dBm	LC/LC	850/850	220/550 m ea.
CCM-5555E	/	/	/	/	/	/	/	/	/	/
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-3131**	SM / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	SC/SC	1310/1310	10Km each
CCM-5531	MM / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	SC/SC	1310 ηm	550m / 10 Km
CCM-5636	MM / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	LC/LC	1310 ηm	550m / 10 Km
CCM-5531L	MM / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC/SC	1310 ηm	550m / 30 Km
CCM-5531XL	MM / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC/SC	1550 ηm	550m / 40 Km
CCM-5531E45	MM / SM	-5.0 dBm	0.0 dBm	-24.0 dBm	19.0 dB	24.0 dB	-3.0 dBm	SC/SC	1550 ηm	550m / 40 Km
CCM-5531E75	MM / SM	-2.0 dBm	3.0 dBm	-24.0 dBm	22.0 dB	27.0 dB	-3.0 dBm	SC/SC	1550 ηm	550m / 70 Km

** NOTE: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or Gigabit Ethernet, Fiber-to-Fiber Data Sheet for additional information*

***Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

More versions of the CCM-55XX series may be found on the Canary web site as they become available.

Fast Ethernet (Standard) UTP to Fiber Converters

CCM-124X – Standard multi-mode & single-mode series: 100BASE-TX to 100BASE-FX

Canary's Fast Ethernet Media Converters connect twisted-pair and fiber optic segments to extend Fast Ethernet links. They are ideal for connecting user desktops with low-cost work-group switches and servers; or for switch-to-switch links. Canary's UTP-to-Fiber Media Converters are used to economically distribute Fast Ethernet capacity to user desktops throughout the network.

CCM-124X converter modules are the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology while supporting Far-End Fault-Indication and parallel detection.

- Card features and performance mirror that of Canary's stand-alone CFT 100 Mbs copper-to-fiber converters
- Switch for Hard-Setting Full-Duplex or 100BASE-T Autonegotiation for 100 Mbs, Full and Half-duplex operation
- Internal Auto-sensing, MDI / MDI-X crossover switch for proper Network Interface Card or Switch connections
- Switch enabled Link Fault Signaling (LFS) – forwards lost link awareness to each connected host
- A full array of status / diagnostic LEDs
- Additional models include: Single-Fiber Bi-Directional single-mode and versions launching ITU-specified CWDM transmitter wavelengths

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CCM-1241	UTP / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	SC	1310 ηm	2000 m
CCM-1242	UTP / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	ST	1310 ηm	2000 m
CCM-1246	UTP / MM	-19.0 dBm	-14.0 dBm	-32.0 dBm	13.0 dB	18.0 dB	-8.0 dBm	LC	1310 ηm	2000 m
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-1281-SM	UTP / SM	-16.0 dBm	-9.0 dBm	-34.0 dBm	18.0 dB	25.0 dB	-7.0 dBm	SC	1310 ηm	18 Km
CCM-1241-SM	UTP / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC	1310 ηm	30 Km
CCM-1242-SM	UTP / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	ST	1310 ηm	30 Km
CCM-1246-SM	UTP / SM	-15.0 dBm	-8.0 dBm	-28.0 dBm	13.0 dB	20.0 dB	-8.0 dBm	LC	1310 ηm	20 Km
CCM-1241-LSM	UTP / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC	1310 ηm	50 Km
CCM-1241-XL	UTP / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC	1550 ηm	80 Km
CCM-1241-E85	UTP / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC	1550 ηm	80 Km

**NOTE 1: CCM-124X models are available as uni-Directional (D) versions that allow one-way traffic e.g. CCM-1241D. For special order, contact Canary for information.*

** NOTE 2: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or 100 Mb, UTP-to-Fiber Data Sheet for additional information*

More versions of the CCM-124X series may be found on the Canary web site as they become available.

Fast Ethernet (Standard) Fiber-to-Fiber Converters

CCM-9X2X – Standard 100 Mbs Media Converters: 100BASE-FX to 100BASE-FX

Canary's CCM-9X2X Fast Ethernet Fiber-to-Fiber Media Converters deliver economical long-range Fast data transmission as they link low-cost multi-mode ports with single-mode Fiber optic segments. They are ideal for connecting user desktops with low-cost work-group switches and servers; or for long distance switch-to-switch links. Canary converters were the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology that forwards lost link awareness to each connected host.

Most 100 Mbs Fiber-to-Fiber models support data rates from 10 Mbs through 155 Mbs (OC-3). Although outside of the designed range of data transmission rates, some models have successfully demonstrated ≤ 1 Mbs data transmission in field applications. Contact Canary for more information.

- **Simple plug and go installation**
- **Status / Diagnostic LED Indicators**
- **Automatic Link Fault Signaling (LFS) Forwards lost link awareness to each connected host**
- **Additional models include: Single-Fiber Bi-Directional single-mode and versions launching ITU-specified CWDM transmitter wavelengths**

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
NOTE: Standard multi-mode fiber port connectors are designated by (21 or 22) e.g. (CCM-XX21) or (CCM-XX22) and have common power and sensitivity specifications. Special 850 ηm multi-mode fiber port connectors are designated by (-72-) e.g. (CCM-XX72) and transmit 2 Km @ 10 Mb or 100 Mb. Standard single-mode ports are designated by (91 or 92) e.g. (CCM-91XX) or (CCM-92XX) and have common power and sensitivity specifications.										
CCM-2121*	MM / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	SC/SC	1310/1310	2 Km Each
CCM-2222*	MM / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	ST/ST	1310/1310	2 Km Each
CCM-XX72*	XX / MM	-15.2 dBm	-15.2 dBm	-34.4 dBm	19.2 dB	19.2 dB	NA	/ST	XX/850	2 Km / 10Mb
CCM-XX72*	XX / MM	/	/	/	11.7 dB	17.7 dB	NA	/ST	XX/850	700 m / 100Mb
CFC-XX71 100Mb**	XX / MM	-12.0 dBm	-4.0 dBm	-27.0 dBm	15.0 dB	23.0 dB	3.0 dBm	/SC	850 ηm	2 Km / 100Mb
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-9191*	SM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/SC	1310/1310	30 Km Each
CCM-9172 100Mb	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/ST	1310 ηm	2 Km / 30 Km
CCM-9272 100Mb	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	ST/ST	1310 ηm	2 Km / 30 Km
CCM-9121	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/SC	1310 ηm	2 Km / 30 Km
CCM-9122	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/ST	1310 ηm	2 Km / 30 Km
CCM-9221	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	ST/SC	1310 ηm	2 Km / 30 Km
CCM-9222	MM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	ST/ST	1310 ηm	2 Km / 30 Km
CCM-9121L	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/SC	1310 ηm	2 Km / 50 Km
CCM-9122L	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/ST	1310 ηm	2 Km / 50 Km
CCM-9121XL	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/SC	1550 ηm	2 Km / 80 Km
CCM-9121E85	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/SC	1550 ηm	2 Km / 80 Km
CCM-9122XL	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/ST	1550 ηm	2 Km / 80 Km
CCM-9122E85	MM / SM	-5.0 dBm	0.0 dBm	-35.0 dBm	30.0 dB	35.0 dB	0.0 dBm	SC/ST	1550 ηm	2 Km / 80 Km

** NOTE: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or 100 Mb, Fiber-to-Fiber Data Sheet for additional information*

** Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

*** This CFC-XX71 version supports data rates of 10 & 100 Mbs through OC-3, uses an SC-type fiber connector and has more powerful 850 ηm optics that supports two-Kilometer transmissions*

More versions of the CCM Fiber-to-Fiber converters may be found on the Canary web site as they become available.

10Mbs Converters

CCM-120X – Standard 10 Mbs Media Converters: 10BASE-T / 10BASE-2 / 10BASE-FL

Canary CCM-120X Media Converter modules are long-time standards for 10Mbs media conversion, and are still available for legacy applications. They provide flexible combinations of BNC/ UTP, BNC/Fiber, and UTP/Fiber Conversion. Fiber ports provide multi-mode or single mode connections.

- **Media Converter modules are Compliant with IEEE 802.3 10 Mbs Ethernet standards**
- **10 Mbs Copper-to-Fiber modules are transparent to Full and Half-duplex traffic**
- **Models with BNC connectors have a switch for internal 50 Ohm Termination**
- **Models with Fiber connectors are compatible with 10BASE-FL (FOIRL)**
- **Models with UTP connectors have Auto-polarity protection**
- **Full array of status / diagnostic LEDs**

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Connector Type	Wavelengths (ηm)	Transmit Distance
Multi-mode fiber specifications are in blue									
CCM-1201	BNC / MM	-15.2 dBm	-15.2 dBm	-34.4 dBm	19.2 dB	19.2 dB	ST	850	185m/ 2 Km
CCM-1201-SM	BNC / SM	-23.0 dBm	-17.0 dBm	-32 / -35 dBm	9.0 dB	18.0 dB	ST	1310	185m/ 4 Km
CCM-1202	UTP / MM	-15.2 dBm	-15.2dBm	-34.4 dBm	19.2 dB	19.2 dB	ST	850	100m/ 2 Km
CCM-1202-SC	UTP / MM	-15.2 dBm	-15.2dBm	-34.4 dBm	19.2 dB	19.2 dB	SC	850	100m/ 2 Km
CCM-1202-SM	UTP / SM	-23.0 dBm	-17.0 dBm	-32 / -35 dBm	9.0 dB	18.0 dB	ST	1310	100m/ 15 Km
CCM-1203	UTP / BNC	NA	NA	NA	NA	NA	RJ-45 / BNC	NA	100m/ 185 m

NOTE: CCM-120X converter modules are available as standalone units. Please refer to the 10 Mbs MCC-20XX Data Sheet for additional information.

Cable Specifications:
- BNC: 50 Ohm RG-58(U) ThinNet
- UTP: Category 3,5 Twisted Pair
- Fiber:
  Multi-mode: 50.0/125, 62.5/125, 100/125 μm
  Single-mode: 8.7-9.0/125 μm

LED Indicators:
- Activity, Auto Polarity, Collision, Jabber, Link, Link Fault Signaling, Power

Single-Fiber, Bi-Directional Single-Mode Converters for Gigabit and Fast Ethernet

Canary's Media Converters with Single-Fiber Bi-Directional Single-mode Connectors deliver long-range data access over single-mode segments while using a single strand of Fiber cable. CCM Single Fiber converters are designed to free-up fiber capacity by using dual transmission wavelengths over a single strand of a duplex fiber pair. They are ideal for data intensive backbones in the enterprise or across the campus where extra fiber capacity is lacking but redundancy or additional access is needed to add channels or alternate protocols.

CCM-1600 Single-Fiber, Bi-Directional Converters are functionally identical to standard units with the exception that versions designated with an A transmit at 1550 ηm and receive on 1310 ηm, while B units transmit at 1310 ηm and receive on 1550 ηm. Single-Fiber converters must be connected as complementary A & B pairs. (A and B units must be ordered in pairs because every A unit must be connected to a B unit.) For a properly functioning fiber link, one unit A must be purchased and installed on one end and one unit B must be purchased and installed at the other end. Similarly, Standalone or CCN-2000/CCN-0400 chassis A & B units, can also be connected to complementary A & B modules used in the CCM-1600 Chassis.

Gigabit Ethernet UTP-to-Single Fiber Converters

CCM-1037A/B – Gigabit Ethernet UTP-to-Single-Fiber, Bi-Directional Single-Mode

Canary CCM-1037A and CCM-1037B Gigabit Ethernet UTP-to-Single-Fiber converters are available with 20 kilometer and 40 kilometer transmission ranges. They function identically to units with standard duplex fiber connectors … and must be connected as complementary A & B units.

- 1000BASE-T Autonegotiation for Full-duplex and Half-duplex operation with Flow-Control and;
- 1000BASE-z Fiber Specifications
- Switch selectable, Fiber-Port Autonegotiation for common, end-to-end link awareness and Flow-Control, or for independent connection to Gigabit fiber ports on older switches
- Internal Auto-sensing, MDI / MDI-X crossover switch for Network Interface Card or Switch connections
- Uses Single-Fiber, single-mode connectors operating on 1550 ηm and 1310 ηm wavelengths
- Transparent to Flow-Control commands such as PAUSE
- A full array of status / diagnostic LEDs

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CCM-1037A	UTP / SM	-8.0 dBm	-3.0 dBm	-21.0 dBm	13.0 dB	18.0 dB	-3.0 dBm	SC	1550/1310	20 Km
CCM-1037B	UTP / SM	-8.0 dBm	-3.0 dBm	-21.0 dBm	13.0 dB	18.0 dB	-3.0 dBm	SC	1310/1550	20 Km
CCM-1037E4A	UTP / SM	-3.0 dBm	2.0 dBm	-23.0 dBm	20.0 dB	25.0 dB	-3.0 dBm	SC	1550/1310	40 Km
CCM-1037E4B	UTP / SM	-3.0 dBm	2.0 dBm	-23.0 dBm	20.0 dB	25.0 dB	-3.0 dBm	SC	1310/1550	40 Km

** NOTE: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or Gigabit Ethernet Single-Fiber, UTP-to-Fiber Data Sheet for additional information*

More versions of the CCM-1037A/B series may be found on the Canary web site as they become available.

Gigabit Duplex-Fiber to Single-Fiber Converters

CCM-5537A/B – Gigabit Duplex-Fiber to Single-Fiber, Bi-Directional Single-Mode

Canary CCM-5537A and CCM-5537B Gigabit Ethernet Fiber-to-Fiber, Single-Fiber Bi-Directional Media Converter modules are available with 20 kilometer and 40 kilometer transmission ranges. Single-fiber converters must be connected as complementary A & B pairs.

Standard Gigabit CCM-1600 multi-mode ports provide minimum transmission distances of 220+ meters over 62.5/125 μm fiber or 500+ meters over 50.0/125 μm fiber.

- Simple plug and go installation
- Transparent to Flow-Control commands such as PAUSE
- Uses Single-Fiber, single-mode connectors operating on 1550 ηm and 1310 ηm wavelengths
- 1000BASE-z Fiber Specifications
- Diagnostic and status LEDs

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CCM converters with standard multi-mode fiber port connectors are designated by (CCM-55XX) or (CCM-56XX) and have common power and sensitivity specifications. Standard single--mode fiber port connectors are designated by (-31-) e.g. (CCM-XX31) or (CCM-31XX)										
CCM-5555 **	MM / MM	-9.5 dBm	-4.0 dBm	-17.0 dBm	7.5 dB	13.0 dB	0.0 dBm	SC/SC	850/850	220/550 m ea.
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-3131 **	SM / SM	-10.0 dBm	-3.0 dBm	-20.0 dBm	10.0 dB	17.0 dB	-3.0 dBm	SC/SC	1310/1310	10Km each
CCM-5537A	MM / SM	-8.0 dBm	-3.0 dBm	-21.0 dBm	13.0 dB	18.0 dB	-3.0 dBm	SC/SC	1550/1310	550m / 20 Km
CCM-5537B	MM / SM	-8.0 dBm	-3.0 dBm	-21.0 dBm	13.0 dB	18.0 dB	-3.0 dBm	SC/SC	1310/1550	550m / 20 Km
CCM-5537E4A	MM / SM	-3.0 dBm	2.0 dBm	-23.0 dBm	20.0 dB	25.0 dB	-3.0 dBm	SC/SC	1550/1310	550m / 40 Km
CCM-5537E4B	MM / SM	-3.0 dBm	2.0 dBm	-23.0 dBm	20.0 dB	25.0 dB	-3.0 dBm	SC/SC	1310/1550	550m / 40 Km
GFC-3137A	MM / SM	-8.0 dBm	-3.0 dBm	-21.0 dBm	13.0 dB	18.0 dB	-3.0 dBm	SC/SC	1550/1310	10 Km / 20 Km
CCM-3137B	SM / SM	-3.0 dBm	2.0 dBm	-23.0 dBm	20.0 dB	25.0 dB	-3.0 dBm	SC/SC	1310/1550	10 Km / 20 Km

** NOTE: CCM Chassis converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or Gigabit Ethernet Single-Fiber, Fiber-to-Fiber Data Sheet for additional information*

*** Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

More versions of the CCM-5537A/B series may be found on the Canary web site as they become available.

Fast Ethernet UTP-to-Single Fiber Converters

CCM-1247A/B – Fast Ethernet UTP-to-Single Fiber, Bi-Directional Single-Mode

Canary 100 Mbs UTP / Single-Fiber Media Converters are available with 20, 40 and 60 kilometer transmission ranges. They function identically to units with standard duplex fiber connectors. CCM-1247A and CCM-1247B Media Converters are the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology while supporting Far-End Fault-Indication and parallel detection. Single-fiber converters must be connected as complementary A & B pairs.

- Switch for Hard-Setting Full-Duplex or 100BASE-TX Autonegotiation for 100 Mbs, Full and Half-duplex operation
- Internal Auto-sensing, MDI / MDI-X crossover switch for proper Network Interface Card or Switch connections
- Switch enabled Link Fault Signaling (LFS) – Forwards lost link signals to each connected host
- Uses Single-Fiber, single-mode connectors operating on 1550 ηm and 1310 ηm wavelengths
- A full array of status / diagnostic LEDs

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CCM-1247SA	UTP / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC	1550/1310	20 Km
CCM-1247SB	UTP / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC	1310/1550	20 Km
CCM-1247E4A	UTP / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC	1550/1310	40 Km
CCM-1247E4B	UTP / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC	1310/1550	40 Km
CCM-1247E6A	UTP / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC	1550/1310	60 Km
CCM-1247E6B	UTP / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC	1310/1550	60 Km

** NOTE: CCM Chassis Single-Fiber converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or 100Mbs Single-Fiber, UTP-to-Fiber Data Sheet for additional information*

More versions of the CCM-1247A/B series may be found on the Canary web site as they become available.

Fast Ethernet Duplex Fiber to Single-Fiber Converters

CCM-972X A/B and CCM-979X A/B – Fast Ethernet Duplex-Fiber to Single-Fiber Bi-Directional Converters

Canary 100 Mbs Fiber-to-Single-Fiber Media Converters are available with 20 kilometer, 40 kilometer and 60 kilometer transmission ranges. CCM-972XA/B and CCM-979XA/B Media Converters are the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology. Most versions transmit between 10 Mbs and 155 Mbs (OC-3) data rates. Although outside of the designed data range, some models have successfully demonstrated ≤ 1 Mbs data transmission in field applications. Contact Canary for more information. Single-fiber converters must be connected as complementary A & B pairs.

- Simple plug and go installation
- Status / Diagnostic LED Indicators
- Automatic Link Fault Signaling (LFS) Forwards lost link awareness to each connected host
- Uses Single-Fiber, single-mode connectors operating on 1550 hm and 1310 hm wavelengths
- 100 BASE-FX Fiber Specifications

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
NOTE: Standard multi-mode fiber port connectors are designated by (21 or 22) e.g. (CCM-XX21) or (CCM-XX22) and have common power and sensitivity specifications. Standard single-mode ports are designated by (91 or 92) e.g. (CCM-XX91) or (CCM-XX92) and have common power and sensitivity specifications. Single-Fiber ports are designated by (97) e.g. (CCM-97XXA) or (CCM-97XXB)										
CCM-2121 **	MM / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	SC/SC	1310/1310	2 Km Each
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode, fiber connectors.										
CCM-9191 **	SM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/SC	1310/1310	30 Km Each
CCM-9721A	MM / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC/SC	1550/1310	20 Km
CCM-9721B	MM / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC/SC	1310/1550	20 Km
CCM-9721E4A	MM / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC/SC	1550/1310	40 Km
CCM-9721E4B	MM / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC/SC	1310/1550	40 Km
CCM-9721E6A	MM / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC/SC	1550/1310	60 Km
CCM-9721E6B	MM / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC/SC	1310/1550	60 Km
CCM-9791A	SM / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC/SC	1550/1310	20 Km
CCM-9791B	SM / SM	-14.0 dBm	-8.0 dBm	-33.0 dBm	19.0 dB	25.0 dB	-3.0 dBm	SC/SC	1310/1550	20 Km
CCM-9791E4A	SM / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC/SC	1550/1310	40 Km
CCM-9791E4B	SM / SM	-8.0 dBm	-3.0 dBm	-33.0 dBm	25.0 dB	30.0 dB	-3.0 dBm	SC/SC	1310/1550	40 Km
CCM-9791E6A	SM / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC/SC	1550/1310	60 Km
CCM-9791E6B	SM / SM	-5.0 dBm	0.0 dBm	-33.0 dBm	28.0 dB	33.0 dB	-3.0 dBm	SC/SC	1310/1550	60 Km

** NOTE: CCM Chassis Single-Fiber converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or 100Mbs Single-Fiber, Fiber-to-Fiber Data Sheet for additional information*

*** Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

More versions of the CCM-972XA/B series may be found on the Canary web site as they become available.

Coarse Wavelength Division Multiplexing

CWDM Multiplexer Modules and Media Converters

The CCM-1600 Chassis Group includes Coarse Wavelength Division Multiplexer* modules and CWDM Media Converters. Canary Communications' approach to the CWDM solution is outlined below, followed by ordering information for CCM-1600 Chassis Passive and Active Modules. Users who would like a Coarse Wavelength Division Multiplexing overview will find that discussion as one of the two appendices to this data-sheet. The other appendix provides Optical Insertion Loss tables and examples of Optical Insertion Loss calculations.

The Canary Communications Coarse Wavelength Division Multiplexing solution

Canary's approach to the CWDM marketplace and its deployment is derived from a simple premise based on the following **beliefs**:

- Any network using long distance single-mode fiber that needs more bandwidth can benefit by deploying CWDM Technology.
- Deploying and using CWDM Technology does not require "new", complex, "fully integrated" processor hardware with all the "bells and whistles".
- A basic CWDM installation can deliver most of the benefits of a much more complex one – at a much lower total cost of ownership.
- An experienced network administrator/integrator has the requisite skills to confidently deploy and use CWDM Technology.
- CWDM Technology does not mandate a rigid "one size fits all" mentality or approach to its deployment– (it) is modular, highly scalable, and is flexible enough to meet most user needs.

These beliefs led to the following **design principles**:

- If more single-mode bandwidth is needed, CWDM Technology is the solution.
- Deploying and using CWDM Technology does not have to be complex.
- Deploying and using CWDM Technology does not have to be expensive.
- Deploying and using CWDM Technology does not have to be difficult.
- CWDM Technology should be used when network scalability, flexibility, and cost are key.

NOTES

***Usage:** Throughout this document the acronym CWDM is used in two contexts: It encompasses Coarse Wavelength Division Multiplexing technology as a whole. Or more narrowly, it can refer to Coarse Wavelength Division Multiplexer/De-Multiplexer (mux/demux) hardware that optically combines transmitted wavelengths into a multiplexed data stream or partitions them, when received, into individual channels.

Coarse Wavelength Division Multiplexing

CWDM Multiplexer Modules and Media Converters

Canary's premise is that users can enjoy the full benefit of CWDM Technology, scaled to their exact needs, by using a simple, modular, building-block approach to its deployment. Canary's product development philosophy is to leverage the marketplace's familiarity and long experience with Media Converters and their use to make CWDM Technology understandable, easily deployable, and, above all, economical to use.

Canary's CWDM product offering implements the above premises in the following ways:

1. Canary offers a wide range of Multiplexer/De-Multiplexer equipment with access capability for four, eight, and twelve user data-channels over duplex fiber, or four user channels over a single fiber strand. The Multiplexers are available in various form factors– standalone/rackable chassis and as slide-in modules for our multi-port CCM-1600 and Manageable CCN-2000 Converter Chassis families.
2. Canary's selection of Optical Add/Drop Multiplexers (OADMs)* allows one, two, or four user-channels to exit and return to a CWDM data stream at intermediate locations on the fiber ring. One class of two channel OADMs enables newly inserted or channel return path data to propogate separately in two directions. The fiber segment is effectively split into two virtual segments at that point.
3. Active Media Converters are available to provide CWDM access for users with standard UTP or multi-mode Fiber connections, with CWDM transmitters providing several different power levels. Protocols supported by CWDM Conversion include Gigabit Ethernet, Fast Ethernet, and Fibre Channel.
4. Modular CWDM Converter cards are available for the Canary CCM-1600 and CCN-2000 chassis families.
5. A CCM-1600 or CCN-2000 chassis can be configured with one slide-in Multiplexer/De-Multiplexer Module and the needed Media Converter Modules to convert standard interfaces to CWDM wavelengths. The resulting package will operate as a self-contained unit.
6. Canary's CWDM Converter Modules are backward-compatible with older installed multi-port Converters. If a Canary multi-port chassis is already installed, upgrading to full CWDM capability is as simple as installing a Multiplexer Module and changing a few Converter Cards.

The Canary CWDM products that follow reflect and apply this efficient, cost-effective, and user-friendly design and development philosophy and approach.

Pages 16 through 26 provide ordering information for the following CCM-1600 Chassis Group modules:

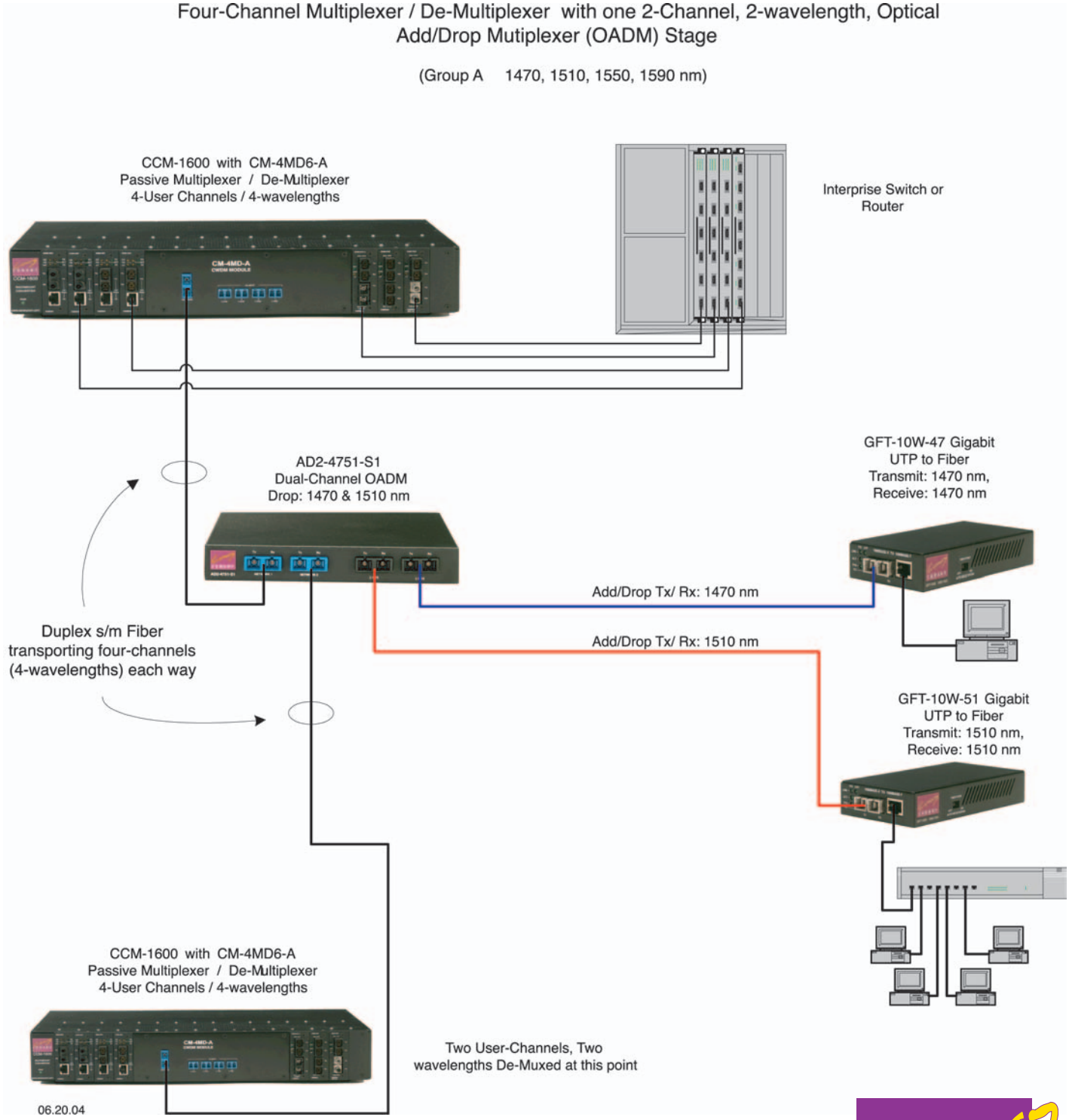
- ***Passive Ethernet CWDM Multiplexer/ De-Multiplexer Modules***
  (pg 22)
- ***Gigabit Ethernet UTP-to-Fiber CWDM Converter Modules***
  (pg 23)
- ***Gigabit Ethernet Fiber-to-Fiber CWDM Converter Modules***
  (pg 24)
- ***Fast Ethernet UTP-to-Fiber CWDM Converter Modules***
  (pg 25)
- ***Fast Ethernet Fiber-to-Fiber CWDM Converter Modules***
  (pg 26)

NOTES

*Detailed product information on Canary's Optical Add/Drop Multiplexer products can be found in the separate Coarse Wavelength Division Multiplexing data sheet included with this CD catalog.

CWDM Modules and Converters

Figure 1



Coarse Wavelength Division Multiplexing

Standard Four and Eight Channel Multiplexer/De-Multiplexer Modules

Canary's economical Coarse Wavelength Division Multiplexers (CWDMs) accomplish the process of combining and launching in parallel, multiple user data channels as a single, transmitted multi-wavelength data stream. The process uses completely passive, un-powered, optical components. In addition, CWDMs partition (de-mux) incoming multiplexed optical signals and distribute the individual traffic channels to their respective users. Standard Multiplexer/De-Multiplexer versions launch four and eight user-channels (wavelengths) across a single-mode duplex fiber segment. They are used in conjunction with specific Canary Media Converter models that provide *active* signal transmission using one of the eight specific CWDM wavelengths. They are also compatible with wavelength outputs from other CWDM-capable devices. It is important to insure that all interconnected CWDM devices, passive and active, be carefully matched as to wavelengths (channels) being allocated to specific user devices and their signal propagation paths across the fiber network. Keeping track of wavelength assignments is the sine qua non for successful CWDM installations.

Organizations deploying Coarse Wavelength Division Multiplexing technology are able to increase user access, add redundancy and reduce network congestion with a minimum infrastructure investment. With CWDM connections, multiple network users, subnets or VPNs can simultaneously access single-mode fiber links that were formerly limited to single Server and Switch backbone type connections.

Canary Coarse Wavelength Division Multiplexers are available as modules for both the CCM-1600 and CCN-2000 chassis media converter families and as Standalone, rackable versions.

Features include:

- Eight standard wavelengths available for standard single-mode fiber
- Four additional wavelengths (O-band) available for twelve channels
- Compatible with other vendor's CWDM transmitters
- Compatible with chassis-based CWDM modules
- Client ports use LC connectors
- Economical and flexible network installations
- No power required for operation
- Transparent to protocol type
- Simple plug and go installation

Please refer to Figures 1 and 2 for a generalized view of connection layouts using Multiplexer / De-Multiplexers and Optical Add Drop Multiplexers (OADMs) for user access at intermediate locations. Canary's OADMs enable selected channel wavelengths to "Drop" (exit) and be "Added" (re-inserted) into a multi-wavelength, single-mode data stream – this allows intermediate locations between host sites to access the common, point-to-point fiber segment linking them.

NOTES

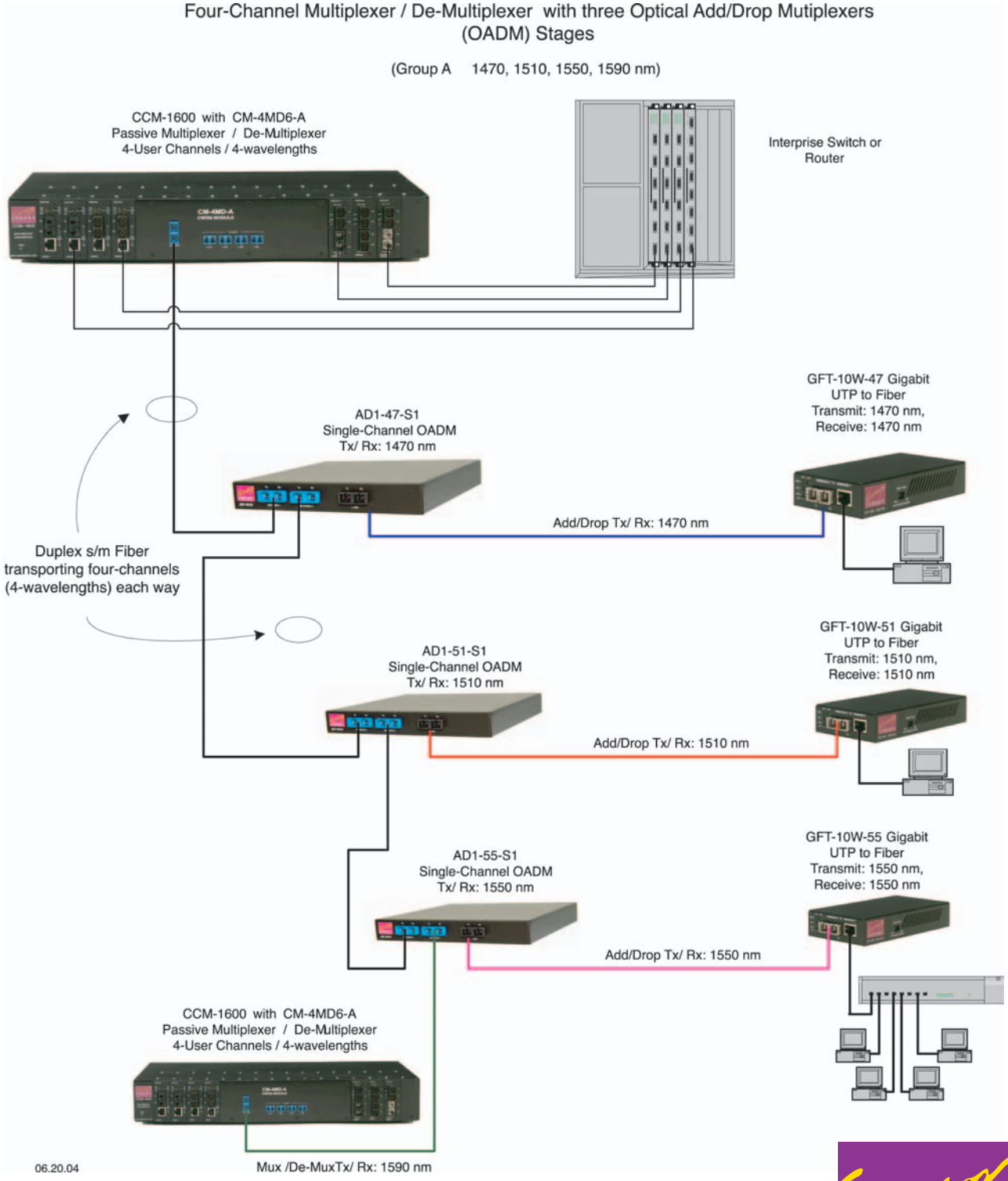
1. It is recommended that Canary passive CWDM multiplexer/de-multiplexer and OADM devices only be paired with other Canary passive CWDM devices for proper functioning. This is necessary in order to balance end-to-end Optical Insertion Losses across all multiplexed wavelengths. Outgoing (traffic) CWDM wavelengths are internally combined in a certain sequence during the multiplexing stage, with the first inserted wavelength subject to proportionally greater Optical Loss than the last wavelength inserted. The incoming multiplexed data stream at the remote site is separated and distributed in the same order sequence during the de-multiplexer stage. Thus the first wavelength de-muxed incurs a lower loss than the last wavelength de-muxed. This paired arrangement proportionally matches high losses accrued during the mux stage per wavelength with low losses incurred during the de-mux stage – in the process balancing end-to-end Optical Insertion Losses across all wavelengths. Canary Optical Add/Drop Multiplexers (OADMs) that drop and insert more than one wavelength are subject to the same phenomena and are handled in a similar fashion.

2. Optical Attenuators may need to be installed to avoid overdriving the *active* CWDM transceivers if the fiber span is too short. Optical Insertion Loss tables to be used for calculating accumulated device Losses are included in the final section of this data sheet as well as sample Insertion Loss calculation examples. Please refer to the Optical Insertion Loss Table (I-2) for reference.

3. Before placing an order for Passive and Active CWDM components, an end-to-end network Power Budget Calculation should be completed that includes the additional device Optical Losses incurred when deploying CWDM Multiplexer/De-Multiplexers and OADMs. An accurate estimate of the total expected optical power losses will help in the proper selection of Active CWDM Converters/ Transceivers providing the correct output power ranges. Table I-2 in the Appendix lists the path Optical Insertion Losses through each class of Canary Multiplexer / De-Multiplexers. These values should be used when estimating the combined Optical Power losses that will accrue when deploying CWDM equipment.

CWDM Modules and Converters

Figure 2



Coarse Wavelength Division Multiplexing

Single-Fiber, Bi-Directional CWDM Multiplexer/De-Multiplexers

Single-Fiber, Bi-Directional Multiplexer/De-Multiplexer versions transport four user-channels across a simplex, (single-fiber) single-mode strand. Each of the four user-channels employs two wavelengths – one for outgoing data transmission and one for incoming data reception. In practice, eight wavelengths are paired in use and require two variants of Single-Fiber Multiplexer /De-multiplexers to be linked as complementary pairs. One Single-Fiber variant (SFA) transmits on Group-A wavelengths (λs) and receives on Group-B wavelengths. The other variant (SFB) transmits on Group-B wavelengths and receives on Group-A wavelengths. Together, they form a complementary pair. One SFA version must always be connected to one SFB version for the proper functioning of Single-Fiber, Bi-Directional links. CCM-1600 SFA units can function with any other standalone or CCN-2000 chassis based SFB Multiplexers and visa versa. Single-Fiber multiplexers are ideal for maintaining or increasing user access when available fiber is limited to a single strand or is being redeployed for other uses.

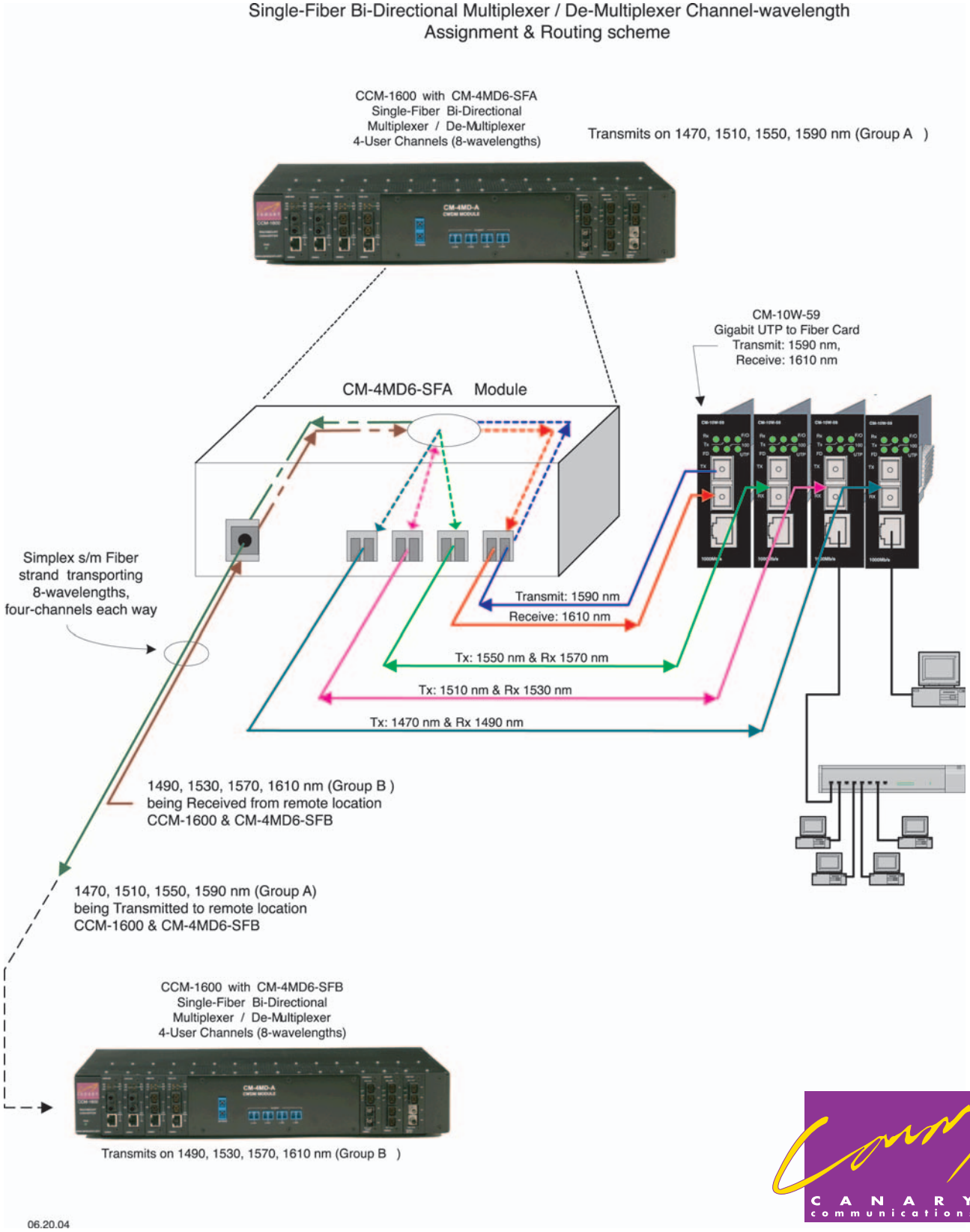
Canary Single-Fiber, Bi-Directional Coarse Wavelength Division Multiplexers use completely passive, un-powered, optical components and are available as modules for both the CCM-1600 and CCN-2000 chassis media converter families and as standalone versions.

Please refer to Figure 3 to view a Single-Fiber Bi-Directional connection scheme.

- **Four user channels supported over a single fiber strand**
- **Compatible with other vendor's CWDM transmitters**
- **Connects with chassis-based CWDM modules**
- **Economical and flexible network installations**
- **Helps conserve limited fiber infrastructure**
- **No power required for operation**
- **Transparent to protocol type**
- **Simple plug and go installationostic LEDs**

CWDM Modules and Converters

Figure 3


Single-Fiber Bi-Directional Multiplexer / De-Multiplexer Channel-wavelength Assignment & Routing scheme
CCM-1600 with CM-4MD6-SFA Single-Fiber Bi-Directional Multiplexer / De-Multiplexer 4-User Channels (8-wavelengths)
Transmits on 1470, 1510, 1550, 1590 nm (Group A)
CM-10W-59 Gigabit UTP to Fiber Card Transmit: 1590 nm, Receive: 1610 nm
CM-4MD6-SFA Module
Simplex s/m Fiber strand transporting 8-wavelengths, four-channels each way
Transmit: 1590 nm
Receive: 1610 nm
Tx: 1550 nm & Rx 1570 nm
Tx: 1510 nm & Rx 1530 nm
Tx: 1470 nm & Rx 1490 nm
1490, 1530, 1570, 1610 nm (Group B) being Received from remote location CCM-1600 & CM-4MD6-SFB
1470, 1510, 1550, 1590 nm (Group A) being Transmitted to remote location CCM-1600 & CM-4MD6-SFB
CCM-1600 with CM-4MD6-SFB Single-Fiber Bi-Directional Multiplexer / De-Multiplexer 4-User Channels (8-wavelengths)
Transmits on 1490, 1530, 1570, 1610 nm (Group B)
06.20.04

Chassis CWDM Multiplexer/Demultiplexer Modules

CM-XMD6-X – Passive Optical CWDM Multiplexer/Demultiplexer Modules

Ordering Information

Model Numbers	Description	ITU-CWDM Wavelengths (λ) in nano- meters (ηm)	Power Source	Shipping Weight
CCM-1600	16-Slot chassis + single AC Power Supply	N/A	115/230VAC	8.0 lb (3.6 Kg)
CM-4MD6-A	4-Channel Mux/Demux, Group A λs (LC clients)	1470, 1510, 1550, 1590	None	18 lb (0.8 Kg)
CM-4MD6-B	4-Channel Mux/Demux, Group B λs (LC clients)	1490, 1530, 1570, 1610	None	18 lb (0.8 Kg)
CM-4MD6-C	4-Channel Mux/Demux, Group C λs (LC clients)	1290, 1310, 1330, 1350	None	18 lb (0.8 Kg)
CM-4MD6-D	4-Channel Mux/Demux, Group D λs (LC clients)	1390, 1410, 1430, 1450	None	18 lb (0.8 Kg)
CM-4MD6-M	4-Channel Mux/Demux, Group M λs (LC clients)	1310, 1330, 1350, 1370	None	18 lb (0.8 Kg)
CM-4MD6-SFA *	4-Channel Mux/Demux, Single-Fiber Bi-Directional	TX: 1470, 1510, 1550, 1590 / RX: 1490, 1530, 1570, 1610	None	18 lb (0.8 Kg)
CM-4MD6-SFB *	4-Channel Mux/Demux, Single-Fiber Bi-Directional	TX: 1490, 1530, 1570, 1610 / RX: 1470, 1510, 1550, 1590	None	18 lb (0.8 Kg)
CM-8MD6-E	8-Channel Mux/Demux, Group E λs (LC clients)	1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610	None	18 lb (0.8 Kg)
CM-8MD6-F	8-Channel Mux/Demux, Group F λs (LC clients)	1290, 1310, 1330, 1350, 1390, 1410, 1430, 1450	None	18 lb (0.8 Kg)
CM-8MD6-M	8-Channel Mux/Demux, Group M λs (LC clients)	1310, 1330, 1350, 1370, 1390, 1410, 1430, 1450	None	18 lb (0.8 Kg)
CBL-SM-1/6	12-inch s/m Fiber jumper cable (SC/LC): Couples Optical output from Chassis *active* CWDM transceivers to *passive* Multiplexer/De-Multiplexer module (LC) ports. One cable required for each *active* CWDM data channel.		N/A	

** Single-Fiber Bi-Directional, 4-channel Multiplexer/De-Multiplexers must be connected as complementary SFA & SFB pairs i.e. one SFA unit must be connected with one SFB unit to establish a proper, functioning data link across the single-mode fiber cable.*

All models of Passive Multiplexer / De-Multiplexers & OADMs use SC connectors as standard for single-mode network (loop) connections. Client ports are LC style fiber connectors.

There are eighteen CWDM wavelengths (λs) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber. Canary offers products for the standard eight wavelengths plus four O-band λs: 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

NOTE: CM-XMD6-X chassis Multiplexer / Demultiplexer modules are available as Standalone / Rackable (CR) units or as modules for the SNMP / WEB manageable, 20-slot CCN-2000 chassis or 4-slot CCN-0400 chassis group. Please refer to other CWDM product data pages for additional information.

Illustrated: CCM-1600 with installed CM-4MD6-A (4-channel) Mulitplexer Module showing LC (client-port) connections

Gigabit Ethernet UTP-to-Fiber CWDM Converters

CM-10W-XX – Gigabit UTP-to-Fiber Media Converters with Single-mode ITU specified CWDM wavelengths

Illustrated: CCM-1600 with active CWDM converter cards linked to a standalone CR-8MD1-E, eight-channel Multiplexer/De-Multiplexer

Canary's CM-10W-XX series of Gigabit Coarse Wavelength Division Multiplexing (CWDM) Media Converters make the transitions from copper to fiber easy. They provide an economical way to launch Gigabit Ethernet data for transport through CWDM Multiplexers and provide access to high capacity CWDM based networks. CM-10W-XX CWDM Converters function identically to units with standard fiber connectors.

- 1000BASE-T Autonegotiation for Full-duplex and Half-duplex operation with Flow-Control and;
- Switch selectable, Fiber-Port Autonegotiation for common, end-to-end link awareness and Flow-Control, or for independent connection to Gigabit fiber ports on older switches
- Internal Auto-sensing, MDI / MDI-X crossover switch for Network Interface Card or Switch connections
- Transmits individual ITU specified CWDM wavelengths
- 1000BASE-z Fiber Specifications
- Transparent to Flow-Control commands such as PAUSE
- A full array of status / diagnostic LEDs

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CM-10W-XX *	UTP / SM	-5.0 dBm	0.0 dBm	-22.0 dBm	17.0 dB	22.0 dB	-3.0 dBm	SC	1470 - 1610	40 Km
CM-10W-XXE6	UTP / SM	0.0 dBm	5.0 dBm	-24.0 dBm	24.0 dB	29.0 dB	-3.0 dBm	SC	1470 - 1610	60+ Km
CM-10W-XXE8	UTP / SM	dBm	dBm	dBm	dB	dB	dBm	SC	1470 - 1610	80 Km

** NOTE 1: W-XX designates one of eighteen CWDM optical transmission wavelengths (λ) e.g. CM-10W-47 = 1470 ηm or CM-10W-61 = 1610 ηm transmission. Please refer to the CWDM (Coarse Wavelength Division Multiplexing Section for more information.*

** NOTE 2: Gigabit CM-10W-XX converters are available as standalone units or as card modules designed for the CCN-2000 / 0400 SNMP manageable chassis. Please refer to the Gigabit GFT-10XX, UTP-to-Fiber CWDM Data Sheet or the CCN-2000 / CCN-0400 Data Sheets for additional information.*

There are eighteen CWDM wavelengths (λs) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber. Canary offers products for the standard eight wavelengths plus four O-band λs: 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Temperature Dependence of Active CWDM Transmitter Center Wavelengths ≤ 0.08 ηm per degree C

More versions of the CM-10W-XX series may be found on the Canary web site as they become available.

Gigabit Ethernet Fiber-to-Fiber CWDM Converters

CM-55W-XX – Gigabit Fiber-to-Fiber Converters with Single-mode ITU specified CWDM wavelengths

Canary's CM-55W-XX series of Gigabit Coarse Wavelength Division Multiplexing (CWDM) Media Converters provide an economical way to convert multi-mode Gigabit data to CWDM wavelengths for launch and transport through CWDM Multiplexers and provide access to high capacity CWDM based networks. CM-55W-XX CWDM converters function identically to units with standard fiber connections. Standard multi-mode fiber connectors on CN-55W-XX modules provide minimum transmission of 220+ meters over 62.5 μm fiber or 500+ meters over 50.0 μm fiber.

- 1000BASE-SX Multi-mode Connection
- Simple plug and go installation
- Status / Diagnostic LED Indicators
- Transparent to Flow-Control commands such as PAUSE
- Transmits individual ITU specified CWDM wavelengths
- 1000BASE-z Fiber Specifications

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
Gigabit converters with standard multi-mode fiber port connectors are designated by (CCM-55XX) or (CCM-56XX) and have common power and sensitivity specifications										
CCM-5555 **	MM / MM	-9.5 dBm	-4.0 dBm	-17.0 dBm	7.5 dB	13.0 dB	0.0 dBm	SC/SC	850/850	220/550 m ea.
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode CWDM fiber connectors										
CM-55W-XX *	MM / SM	-5.0 dBm	0.0 dBm	-22.0 dBm	17.0 dB	22.0 dB	-3.0 dBm	SC/SC	1470 - 1610	550m / 40 Km
CM-55W-XE6	MM / SM	0.0 dBm	5.0 dBm	-24.0 dBm	24.0 dB	29.0 dB	-3.0 dBm	SC/SC	1470 - 1610	550m / 60 Km
CM-55W-XE8	MM / SM	dBm	dBm	dBm	dB	dB	dBm	SC/SC	1470 - 1610	550m / 80 Km

** NOTE 1: W-XX designates one of eighteen CWDM optical transmission wavelengths (λ) e.g. CM-55W-47 = 1470 ηm or CM-55W-61 = 1610 ηm transmission. Please refer to the CWDM (Coarse Wavelength Division Multiplexing Section for more information.*

** NOTE 2: CM-55W-XX converter cards are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units. Please refer to the CCN-2000 / CCN-0400 Data Sheets or GFC-55W-XX CWDM Data Sheet for additional information.*

*** Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

There are eighteen CWDM wavelengths (λ.s) specified. Eight standard wavelengths plus four O-band λ.s are useable over most standard single-mode fiber. Canary offers products for the standard eight wavelengths plus four O-band λ.s: 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Temperature Dependence of Active CWDM Transmitter Center Wavelengths ≤ 0.08 ηm per degree C

More versions of the CM-55W-XX series may be found on the Canary web site as they become available.

Fast Ethernet UTP-to-Fiber CWDM Converters

CM-12W-XX – 100 Mbs UTP-to-Fiber Converters with Single-mode ITU specified CWDM wavelengths

Illustrated: Chassis with CM-4MD6-A module

CM-12W-XX UTP-to-Fiber CWDM Media Converters provide economical access to CWDM based networks. They are based on standard 100 Megabit units that are the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology. They also support Far-End Fault-Indication and parallel detection.

- Switch for Hard-Setting Full-Duplex or 100BASE-TX Autonegotiation for 100 Mbs, Full and Half-duplex operation
- Internal Auto-sensing, MDI / MDI-X crossover switch for proper Network Interface Card or Switch connections
- Switch enabled Link Fault Signaling (LFS) – Forwards lost link awareness to each connected host
- Transmits individual ITU specified CWDM wavelengths
- 100 BASE-TX UTP Specifications
- A full array of status / diagnostic LEDs

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
CM-12W-XX*	UTP / SM	-5.0 dBm	0.0 dBm	-34.0 dBm	29.0 dB	34.0 dB	-3.0 dBm	SC	1470 - 1610	80 Km
CM-12W-XXE9	UTP / SM	-3.0 dBm	2.0 dBm	-34.0 dBm	31.0 dB	36.0 dB	-3.0 dBm	SC	1470 - 1610	100 Km

** NOTE 1: W-XX designates one of eighteen CWDM optical transmission wavelengths (λ) e.g. CM-12W-47 = 1470 ηm or CM-12W-61 = 1610 ηm transmission.*
Please refer to the CWDM (Coarse Wavelength Division Multiplexing Section for more information.

** NOTE 2: CCM Chassis CWDM converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units.*
Please refer to the CCN-2000 / CCN-0400 Data Sheets or CFT-20XX 100Mbs UTP-to-Fiber CWDM Data Sheet for additional information

There are eighteen CWDM wavelengths (λ.s) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber.
Canary offers products for the standard eight wavelengths plus four O-band λs: 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Temperature Dependence of Active CWDM Transmitter Center Wavelengths ≤ 0.08 ηm per degree C

More versions of the CM-12W-XX series may be found on the Canary web site as they become available.

Fast Ethernet Fiber-to-Fiber CWDM Converters

CM-XXW-XX – 100 Mbs Fiber-to-Fiber Converters with Single-mode ITU specified CWDM wavelengths

Canary's CM-XXW-XX Fiber-to-Fiber CWDM Media Converter modules economically transmit Fast Ethernet fiber data to CWDM multiplexers for transport throughout the network. Most CCM Fiber-to-Fiber Converter models support data rates from 10 Mbs through 155 Mbs (OC-3). Although outside of their designed data range, some models have successfully demonstrated ≤ 1 Mbs data transmission in field applications. Contact Canary for more information. Canary's Fiber-to-Fiber Converters were the first in the industry to speedup Spanning Tree link recovery by employing Link Fault Signaling (LFS) technology that forwards lost link signals to each connected host.

- Simple plug and go installation
- Status / Diagnostic LED Indicators
- Transmits individual ITU specified CWDM wavelengths
- 100 BASE-FX Fiber Specifications
- Automatic Link Fault Signaling (LFS) Forwards lost link awareness to each connected host

Ordering Information

Model Numbers	Media Types	Min. Tx PWR	Max. Tx PWR	Rx Sensitivity	Min. PWR Budget	Max.PWR Budget	Max. Input PWR	Connector Type	Wavelengths (ηm)	Transmit Distance
Standard multi-mode fiber port connectors are designated by (21 or 22) and have common power & sensitivity specifications.										*Standard single-mode*
fiber port connectors are designated by (-91 or 92) and have common power & sensitivity specifications.										
CCM-2121 **	MM / MM	-20.0 dBm	-14.0 dBm	-31.0 dBm	11.0 dB	17.0 dB	-8.0 dBm	SC/SC	1310/1310	2 Km Each
Specifications above in blue are for multi-mode, fiber connectors. Specifications below for single-mode fiber connectors										
CCM-9191 **	SM / SM	-15.0 dBm	-8.0 dBm	-34.0 dBm	19.0 dB	26.0 dB	-7.0 dBm	SC/SC	1310/1310	30 Km Each
CM-21W-XX	MM / SM	-5.0 dBm	0.0 dBm	-34.0 dBm	29.0 dB	34.0 dB	-3.0 dBm	SC/SC	1470 - 1610	2Km / 80 Km
CM-21W-XXE9	MM / SM	-3.0 dBm	2.0 dBm	-34.0 dBm	31.0 dB	36.0 dB	-3.0 dBm	SC/SC	1470 - 1610	2Km / 100Km
CM-91W-XX	SM / SM	-5.0 dBm	0.0 dBm	-34.0 dBm	29.0 dB	34.0 dB	-3.0 dBm	SC/SC	1470 - 1610	30Km / 80Km
CM-91W-XXE9	SM / SM	-3.0 dBm	2.0 dBm	-34.0 dBm	31.0 dB	36.0 dB	-3.0 dBm	SC/SC	1470 - 1610	30Km/100Km

** NOTE 1: W-XX designates one of eighteen CWDM optical transmission wavelengths (λ) e.g. CM-91W-47 = 1470 ηm or CM-91W-61 = 1610 ηm transmission.*
Please refer to the CWDM (Coarse Wavelength Division Multiplexing Section for more information.

** NOTE 2: CCM Chassis CWDM converters are available as card modules designed for Canary's CCN-2000 / CCN-0400 Chassis models and as standalone units.*
Please refer to the CCN-2000 / CCN-0400 Data Sheets or 100Mbs Fiber-to-Fiber CWDM Data Sheet for additional information

*** Reference optical specifications for standard multi-mode or single-mode fiber port connectors. Other table specifications for second (alternate) fiber port connector.*

There are eighteen CWDM wavelengths (λs) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber.
Canary offers products for the standard eight wavelengths plus four O-band λs: 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Temperature Dependence of Active CWDM Transmitter Center Wavelengths ≤ 0.08 ηm per degree C

More versions of the CM-21W-XX or CM-91W-XX series may be found on the Canary web site as they become available.

Appendices

Coarse Wavelength Division Multiplexing Overview

Optical Insertion Loss Calculations

Illustrated: Stack of Canary products with CWDM components

Coarse Wavelength Division Multiplexing

Overview

Why Coarse Wavelength Division Multiplexing?

Coarse Wavelength Division Multiplexing (CWDM)* is a technology that increases the data carrying capacity or bandwidth of single-mode fiber by transporting multiple wavelengths (lambdas) in parallel over it, each wavelength carrying a discrete user data channel. The technique employs completely passive devices that (on one end) optically combine and launch multiple wavelength data channels, and (on the other end) recovers, partitions and distributes them to their respective user destinations. Commonly, eight discrete wavelengths, one lambda (λ) per channel, are used to access existing single-mode links at this time.

CWDM Technology increases user access to existing installed fiber, offers greater system redundancy, and reduces network congestion with a minimum infrastructure investment. With CWDM connections, multiple network users, subnets, or VPNs can access and traverse single-mode links that were formerly limited to single user, Server and Switch backbone-type connections.

There are eighteen unique, ITU-defined CWDM wavelengths available for Gigabit Ethernet and other high-speed protocols. Currently, there are eight ITU CWDM wavelengths available for transmission of Gigabit Ethernet, Fibre Channel and Fast Ethernet over standard SMF-28 type single-mode fiber, with an additional four (O-Band) wavelengths also useable. The remaining wavelengths are subject to excessive optical attenuation over standard single-mode fiber and require the use of special low water-peak (low hydroxyl ion) fiber.

The eighteen wavelengths of the CWDM spectrum are optically separated by twenty nanometers (ηm) spacing. This spacing ensures that correct channel separation is maintained between connected devices even though the transmitter elements are un-cooled and the ambient transmitter temperatures vary across the normal 70ºC network range. In this environment, current technology makes it possible for wavelengths to not drift more than 0.1 ηm/degree C, and with 20 ηm channel spacing, maintains sufficient margin for proper channel separation.

Advantages of CWDM vs. DWDM (Dense Wavelength Division Multiplexing) technology

CWDM has the advantages of less complexity, lower installed and total lifetime cost of ownership, and relatively simple installation; it has lower power and cooling requirements, and is optimized for mid-range (40 to 80+ kilometers) metro and campus networks. CWDM is limited to a maximum of twelve channels over standard SMF-28 type single-mode fiber, and up to eighteen channels if using low attenuation (low water-peak) single-mode fiber. Nevertheless, an eight, twelve, or eighteen fold increase in Fiber bandwidth represents a huge increase in available transmission capacity over traditional approaches, with minimal infrastructure investment.

DWDM has the potential advantage of many more (120 or more tightly-spaced channels) over single-mode fiber, has potentially much greater transmission range, operates over a narrow band (C and L-bands) of light frequencies with outputs ranging between 1530 and 1620 ηm, can be used in the metro space, and can be configured for long-haul applications. There is also considerable field experience in deploying DWDM systems. However, these advantages come with the serious penalties of greater system complexity and much higher initial and lifetime system and manpower costs. These costs are due to the following requirements: The installation on each transmitter module of Peltier Effect Thermal Electric Coolers (TECs) and associated control circuitry needed for precise wavelength management, more powerful laser transceivers with sensitive (expensive) avalanche photo-diode (APD) receivers, greater system power and cooling requirements, erbium doped fiber amplifiers (EDFAs) to boost long range transmission power, more complex passive optics (that have to contend with very narrow wavelength spacing, pass-band power-leveling, four-wave mixing, polarization mode dispersion etc.), and a much larger spare parts inventory.

DWDM potentially offers much greater bandwidth but the initial start-up and life-cycle costs are daunting and significantly greater than those required for a full-featured, high-bandwidth CWDM solution.

NOTES

***Usage:** Throughout this document the acronym CWDM is used in two contexts: It encompasses Coarse Wavelength Division Multiplexing technology as a whole. Or more narrowly, it can refer to Coarse Wavelength Division Multiplexer/De-Multiplexer (mux/demux) hardware that optically combines transmitted wavelengths into a multiplexed data stream or partitions them, when received, into individual channels.

Isolation Values

As noted earlier, optical insertion losses are an important consideration when planning for and ordering passive and active CWDM components.

The following table is for reference only. It lists the (path) Optical Isolation values through each class of Canary (four & eight channel) Multiplexer / De-Multiplexers and OADMs that service one, two and four Client access-channel “Drops” & “Adds”.

Table (I-1)

Model Numbers	Descriptions (OADMs & Multiplexer / De-Multiplexers)	Optical Isolation for each Multiplexer/De-Multiplexer stage (Minimum)	Optical Isolation Per OADM Drop point (Minimum)	Optical Isolation Per OADM Add point (Minimum)	Optical Isolation Per OADM Pass-Thru point (Minimum)
CM-4MD6-A /B	4-Channel Mux/Demux Groups A or B λs (Wavelengths)	> 30.0 dB each	Not Applicable	Not Applicable	Not Applicable
CM-4MD6-SFA*	4-Channel Mux/Demux Single-Fiber, Bi-Directional, TX: Grp. A λs, RX: Grp. B λs	> 30.0 dB each	Not Applicable	Not Applicable	Not Applicable
CM-4MD6-SFB*	4-Channel Mux/Demux Single-Fiber, Bi-Directional, TX: Grp. B λs, RX: Grp. A λs	> 30.0 dB each	Not Applicable	Not Applicable	Not Applicable
CM-8MD6-E/F	8-Channel Mux/Demux Groups E or F λs (Wavelengths)	> 30.0 dB each	Not Applicable	Not Applicable	Not Applicable
The following Optical Add/Drop Multiplexer (OADM) entries are included for reference. Details of their use may be found in the CWDM Passive Multiplexer/De-Multiplexer data sheets					
AD1-47-S1 thru AD1-61-S1	1-Channel OADM, 1-λ One SC Client-Add/Drop port	Not Applicable	> 30.0 dB	> 30.0 dB	> 25.0 dB
AD2-47-S1 thru AD2-61-S1	2-Channel OADM, 1-λ Two SC Client-Add/Drop ports	Not Applicable	> 30.0 dB	> 30.0 dB	> 25.0 dB
AD2-4751-S1 thru AD2-5761-S1	2-Channel OADM, 2-λs Two SC Client-Add/Drop ports	Not Applicable	> 30.0 dB	> 30.0 dB	> 25.0 dB
AD4-4A-S1 and AD4-4B-S1	4-Channel OADM, 4-λs Four SC Client-Add/Drop ports	Not Applicable	> 30.0 dB	> 30.0 dB	> 12.5 dB

** Single-Fiber Bi-Directional, 4-channel Multiplexer/De-Multiplexers must be connected as complementary SFA & SFB pairs i.e. one SFA unit must be connected with one SFB unit to establish a proper, functioning data link across the single-mode fiber cable.*

All models of Passive Multiplexer / De-Multiplexers & OADMs use SC connectors as standard for single-mode network (loop) connections. Client ports are SC style fiber connectors.

There are eighteen CWDM wavelengths (λs) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber. Canary offers products for the standard eight wavelengths plus four O-band λs e.g. 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Optical Insertion Losses

This section presents Optical Insertion Loss values, and demonstrates their use in Optical Loss Budget calculations.

The Optical Insertion Loss examples included herein only consider the accumulated Insertion Losses that are contributed by the equipment supplied by Canary Communications when deploying CWDM Multiplexer/De-Multiplexers and OADMs in a network. A complete Optical Budget for the entire network should be calculated separately.

The following table lists the (path) Optical Insertion Losses through each class of Canary (four & eight channel) Multiplexer / De-Multiplexers and OADMs that service one, two and four Client access-channel "Drops" & "Adds". The tabulated Insertion Loss values are used for estimating the combined Optical Power Losses incurred by an optical signal traversing a series of Passive CWDM Multiplexer or OADM stages.

Table (I-2)

Model Numbers	Descriptions (OADMs & Multiplexer / De-Multiplexers)	Insertion Loss at Multiplexer and/or De-Multiplexer point		Insertion Loss Per OADM Drop point		Insertion Loss Per OADM Add point		Insertion Loss Per OADM Pass-Thru point	
		Typical	Maximum	Typical	Maximum	Typical	Maximum	Typical	Maximum
CM-4MD6-A/B	4-Channel Mux/Demux Groups A or B λs (Wavelengths)	1.2 dB	2.4 dB	Not Applicable		Not Applicable		Not Applicable	
CM-4MD6-SFA*	4-Channel Mux/Demux Single-Fiber, Bi-Directional, TX: Grp. A λs, RX: Grp. B λs	2.4 dB	3.4 dB	Not Applicable		Not Applicable		Not Applicable	
CM-4MD6-SFB*	4-Channel Mux/Demux Single-Fiber, Bi-Directional, TX: Grp. B λs, RX: Grp. A λs	2.4 dB	3.4 dB	Not Applicable		Not Applicable		Not Applicable	
CM-8MD6-E/F	8-Channel Mux/Demux Groups E or F λs (Wavelengths)	2.4 dB	3.4 dB	Not Applicable		Not Applicable		Not Applicable	
The following Optical Add/Drop Multiplexer (OADM) entries are included for reference. Details of their use may be found in the CWDM Passive Multiplexer/De-Multiplexer data sheets.									
AD1-47-S1 thru AD1-61-S1	1-Channel OADM, 1-λ One SC Client-Add/Drop port	Not Applicable		1.0 dB	1.4 dB	1.0 dB	1.4 dB	0.5 dB	1.0 dB
AD2-47-S1 thru AD2-61-S1	2-Channel OADM, 1-λ Two SC Client-Add/Drop ports	Not Applicable		1.0 dB	1.4 dB	1.0 dB	1.4 dB	0.5 dB	1.0 dB
AD2-4751-S1 thru AD2-5761-S1	2-Channel OADM, 2-λs Two SC Client-Add/Drop ports	Not Applicable		1.0 dB	1.7 dB	1.0 dB	1.7 dB	0.8 dB	1.4 dB
AD4-4A-S1 and AD4-4B-S1	4-Channel OADM, 4-λs Four SC Client-Add/Drop ports	Not Applicable		1.0 dB	2.4 dB	1.0 dB	2.4 dB	1.0 dB	2.0 dB

** Single-Fiber Bi-Directional, 4-channel Multiplexer/De-Multiplexers must be connected as complementary SFA & SFB pairs i.e. one SFA unit must be connected with one SFB unit to establish a proper, functioning data link across the single-mode fiber cable.*

All models of Passive Multiplexer / De-Multiplexers & OADMs use SC connectors as standard for single-mode network (loop) connections. Client ports can be either SC or LC style fiber connectors.

There are eighteen CWDM wavelengths (λs) specified. Eight standard wavelengths plus four O-band λs are useable over most standard single-mode fiber. Canary offers products for the standard eight wavelengths plus four O-band λs e.g. 1470, 1490, 1510, 1530, 1550, 1570, 1590, 1610 ηm + 1290, 1310, 1330, 1350 ηm

Optical Insertion Losses

Illustrated: CCM-1600 Chassis connected to a CR-8MD1-E Standalone Multiplexer

The following definitions and explanations are used in estimating accumulated Optical Insertion Losses.

1 Multiplexer/De-Multiplexer stages: where multiple channel wavelengths (four, eight or twelve) are initially combined and coupled to a single-mode fiber cable or de-coupled and separated into individual channels - typically at fiber cable end-points i.e. at Origin CWDM launch-points and at (Remote) CWDM channel end-points.

2. Drop-Point - an OADM function: where one or more wavelengths (user channels) are de-coupled from the fiber cable at an intermediate location along the cable span i.e. a branching point.

3. Add-Point – an OADM function: an intermediate location where one or more wavelengths (user channels) are re-inserted (coupled) onto the fiber cable for the Return-path trip (back) to the CWDM Origin.

4. Pass-Thru – an OADM function: Forwarding or "Passing" through the OADM, that fraction of channel wavelengths that are not being de-coupled at that intermediate point. The forwarded wavelengths continuing along the fiber-cable towards the next intermediate OADM 'Drop'-point or to the Remote site CWDM end-point.

5. The Optical Insertion Losses through each device are treated as equivalent for all wavelengths for calculation purposes.

6. Insertion Loss can be estimated (calculated) in a "forward" direction i.e. from Origin to Remote End-point or from any OADM user-channel "Add/Drop" point forward to the Remote End-point.

7. Total insertion Loss should also be estimated for the Return-path i.e. from the Remote End-point to the Origin, or from any OADM "Add/Drop" point to the Origin.

8. In some cases, calculation results accumulated in a "forward" direction may be equal to the Return-path calculation results, suggesting a symmetrical relationship. This should not be assumed to be always true. In order to identify critical network power-budget constraints, accumulated device Optical Insertion Losses should be independently calculated for each path direction and for each starting point i.e. "Add-Point" (stage) where an optical signal is inserted into the fiber cable.

9. The results of CWDM device Optical Insertion Loss calculations must be factored into other typical network Optical Budget calculations in order to get an accurate estimate of the total fiber optic Power Budget available to the network designer.

Optical Insertion Losses

The following Sections present examples of Optical Insertion Loss estimation with calculations, in tabular form. A simple diagram is included for each example.

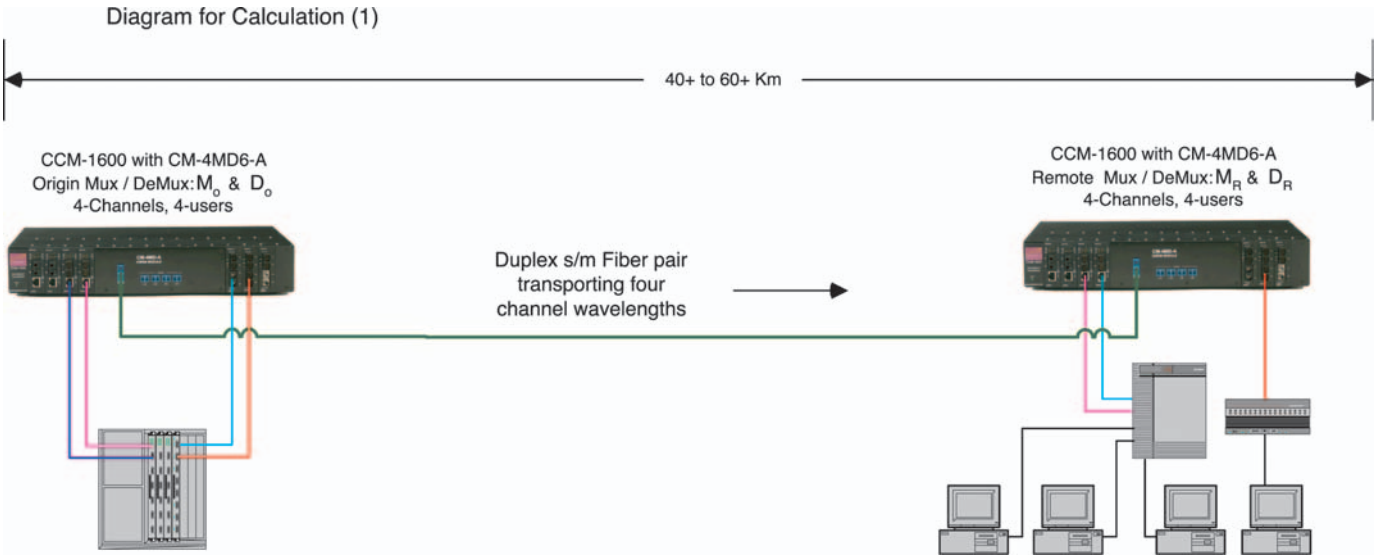
Each diagram displays the logical device-paths used for Optical Insertion Loss calculations through each stage of Canary Multiplexer / De-Multiplexers (four & eight-channels) and OADMs that service one, two and four Client-channel Drops & Adds (signal reinsertions).

Optical Insertion Loss estimation:

- Example 1 of Origin to Remote-Point (link) Loss Calculation with no intermediate OADM (client Drop, Add or Pass-Thru) stages (or their associated OADM Optical Insertion Losses).
- Calculates accumulated typical and maximum path Losses from Origin to Remote end-point.
- Given: Origin and Remote site Multiplexer/De-Multiplexer losses (Mux/De-Mux) and no OADMs in the optical path.
- Origin Chassis Multiplexer/De-Multiplexer (CM-4MD6-A) stage denoted by M_O & D_O and Remote Mux & De-Mux (CM-4MD6-A) stage denoted by M_R & D_R

Table (C-1)

Insertion Loss: Each Mux + De-Mux stage (typically at segment end-points)		Insertion Loss (1st) Drop point	Insertion Loss (1st) Add point	Insertion Loss (1st) Pass-Thru	Acc. Loss at (1st) Drop point	Insertion Loss (2nd) Drop point	Insertion Loss (2nd) Add point	Insertion Loss (2nd) Pass-Thru	Acc. Loss at (2nd) Drop point	Total Loss at end-point Demux w/ no Pass-Thru stages
(M_O & D_O)	(M_R & D_R)									(M_O + D_R)
12 dB	12 dB	None:	None:	None:	None:	None:	None:	None:	None:	
(Typical Optical Loss)		No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	2.4 dB
2.4 dB	2.4 dB	None:	None:	None:	None:	None:	None:	None:	None:	
(Maximum Optical Loss)		No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	No OADM	4.8 dB



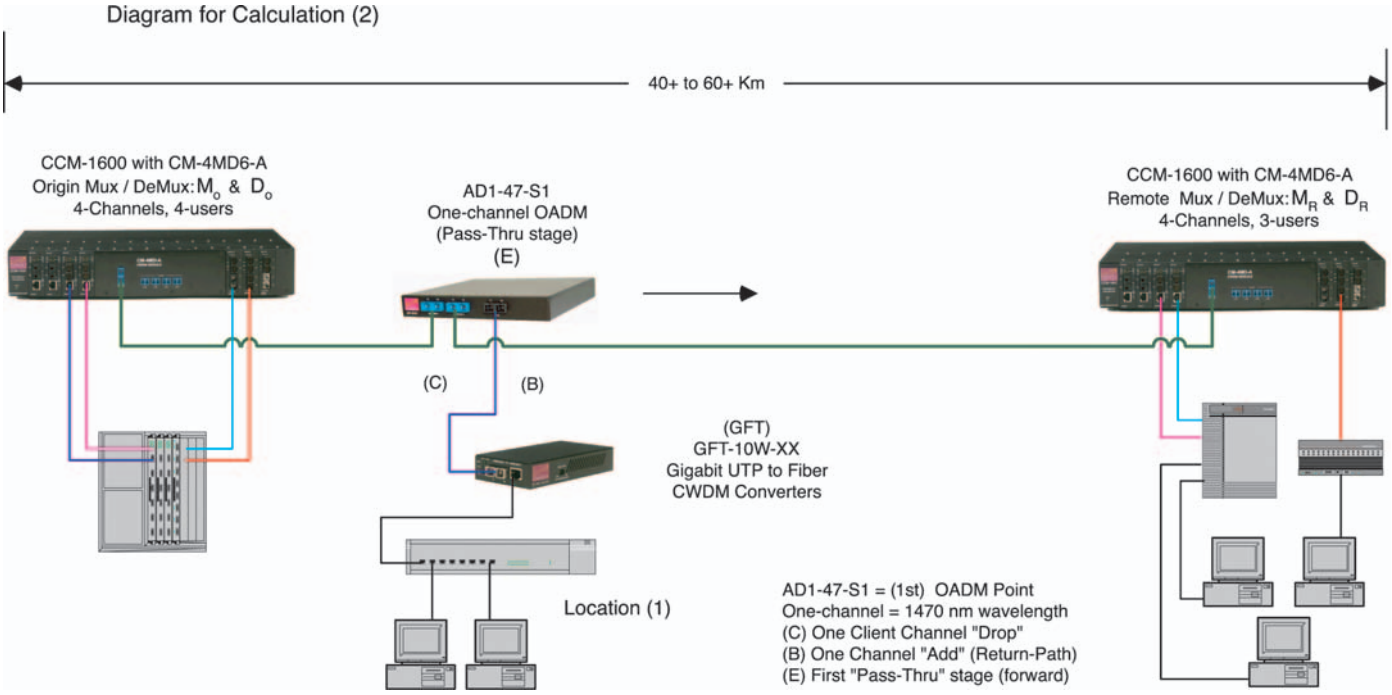
Optical Insertion Losses

Optical Insertion Loss estimation:

- Example 2 of Origin to Remote (Point-to-Point) (link) Loss Calculation with one intermediate OADM (client Drop, Add and Pass-Thru) stage – assumes one λ per Drop (and associated OADM Insertion Losses).
- Calculates accumulated typical and maximum path Losses from Origin through one OADM stage to Remote end-point.
- Given: Origin Multiplexer/De-Multiplexer (CM-4MD6-A) losses (M_O & D_O) and Remote site Mux/De-Mux(CM-4MD6-A) losses (M_R & D_R) plus one OADM point losses (C, B, E) in the optical path.

Table (C-2)

Insertion Loss: Each Mux + De-Mux stage (typically at segment end-points)		Insertion Loss (1st) Drop point	Insertion Loss (1st) Add point	Insertion Loss (1st) Pass-Thru	Acc. Loss at (1st) Drop point	Insertion Loss (2nd) Drop point	Insertion Loss (2nd) Add point	Insertion Loss (2nd) Pass-Thru	Acc. Loss at (2nd) Drop point	Total Loss at end-point Demux w/ one Pass-Thru stage
(M_O & D_O)	(M_R & D_R)	(C)	(B)	(E)	(M_O + C)					(M_O + E + D_R)
12 dB	12 dB	10 dB	10 dB	0.5 dB	2.2 dB	None: No OADM	None: No OADM	None: No OADM	None: No OADM	2.9 dB
(Typical Optical Loss)										
2.4 dB	2.4 dB	14 dB	14 dB	10 dB	3.8 dB	None: No OADM	None: No OADM	None: No OADM	None: No OADM	5.8 dB
(Maximum Optical Loss)										



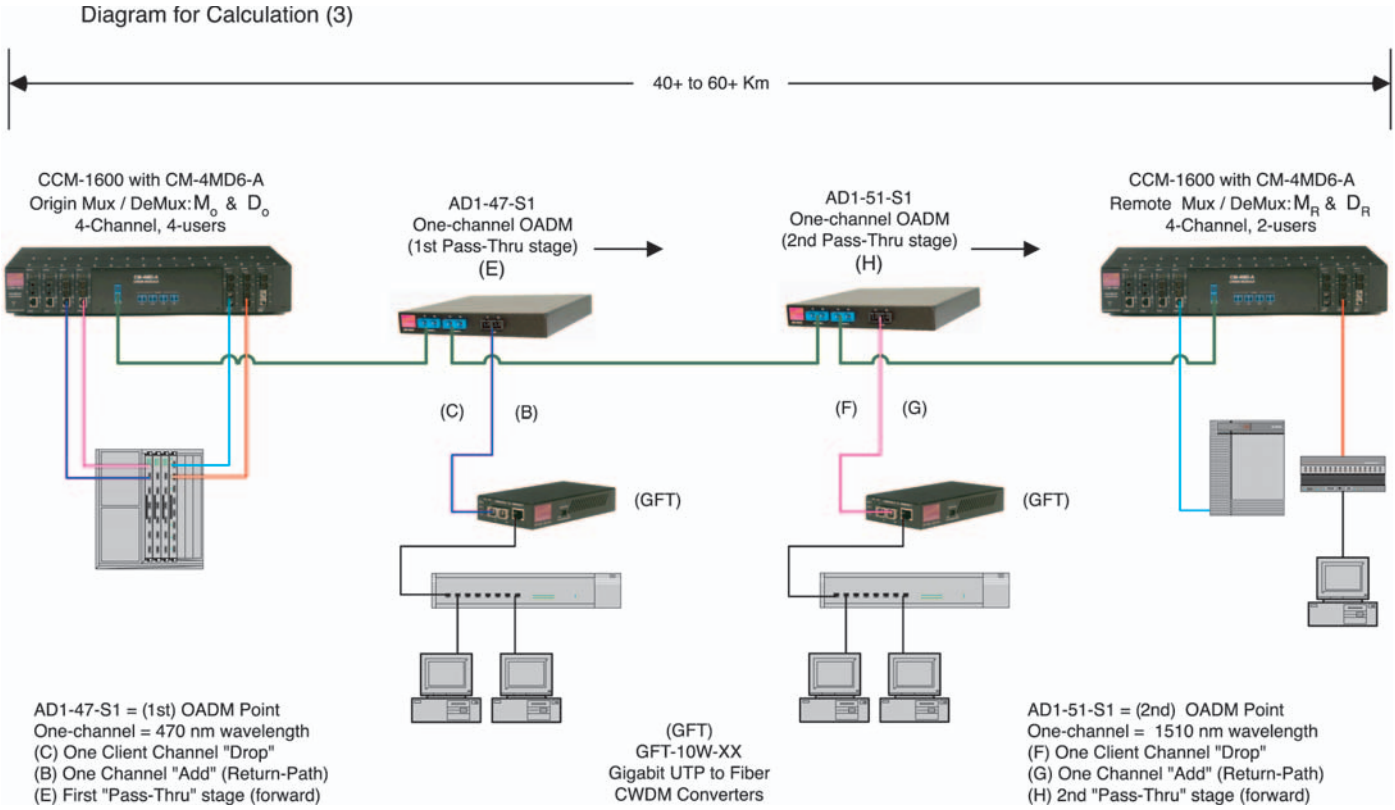
Optical Insertion Losses

Optical Insertion Loss estimation:

- Example 3 of Origin to Remote (Point-to-Point) (link) Loss Calculation with two intermediate, OADM (client Drop, Add and Pass-Thru) stages – assumes one λ per OADM Drop-point.
- Calculates accumulated typical and maximum path Losses from Origin through two OADM stages to Remote end-point.
- Given: Origin Multiplexer/De-Multiplexer (CM-4MD6-A) losses (M_O & D_O) and Remote site Mux/De-Mux (CM-4MD6-A) losses (M_R & D_R) plus two OADM points & losses (C, B, E) and (F, G, H) in the optical path.

Table (C-3)

Insertion Loss: Each Mux + De-Mux stage (typically at segment end-points)		Insertion Loss (1st) Drop point	Insertion Loss (1st) Add point	Insertion Loss (1st) Pass-Thru	Acc. Loss at (1st) Drop point	Insertion Loss (2nd) Drop point	Insertion Loss (2nd) Add point	Insertion Loss (2nd) Pass-Thru	Acc. Loss at (2nd) Drop point	Total Loss at end-point Demux w/ two Pass-Thru stages
(M_O & D_O)	(M_R & D_R)	(C)	(B)	(E)	(M_O + C)	(F)	(G)	(H)	(M_O + E + F)	(M_O + E + H + D_R)
12 dB	12 dB	10 dB	10 dB	0.5 dB	2.2 dB	10 dB	10 dB	0.5 dB	2.7 dB	3.4 dB
(Typical Optical Loss)										
2.4 dB	2.4 dB	14 dB	14 dB	10 dB	3.8 dB	14 dB	14 dB	10 dB	4.8 dB	6.8 dB
(Maximum Optical Loss)										



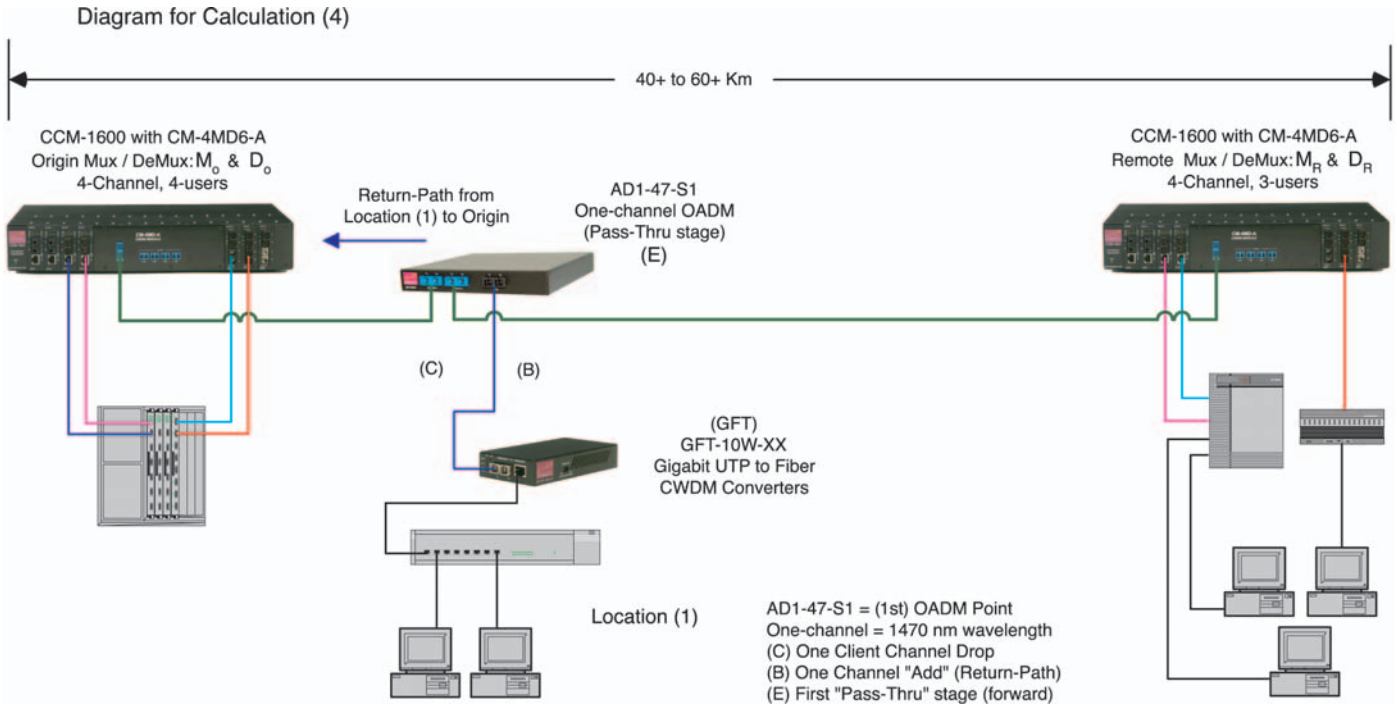
Optical Insertion Losses

Optical Insertion Loss estimation:

- Example 4 of Return-path (link) Loss calculation between one intermediate OADM (client Drop, Add and Pass-Thru) stage and the Origin – assumes one λ per Drop point.
- Calculates typical and maximum Return-path Losses from one OADM (client Add/Drop-point) to Origin.
- Given: Origin Multiplexer/De-Multiplexer (CM-4MD6-A) losses (M_O & D_O) plus one OADM point losses (C, B, E) in the optical path. The Remote site (Mux/De-Mux) is ignored for this calculation example.

Table (C-4)

Insertion Loss: Each Mux + De-Mux stage (typically at segment end-points)		Insertion Loss (1st) Drop point	Insertion Loss (1st) Add point	Insertion Loss (1st) Pass-Thru	Acc. Loss at (1st) Drop point	Insertion Loss (2nd) Drop point	Insertion Loss (2nd) Add point	Insertion Loss (2nd) Pass-Thru	Acc. Loss at (2nd) Drop point	Total Loss at start-point Demux w/ one Add (return) stage & no Pass-Thru stage
(M_O & D_O)	(M_R & D_R)	(C)	(B)	(E)	(M_O + C)					(B + D_O)
12 dB	12 dB	10 dB	10 dB	0.5 dB	2.2 dB	None: No OADM	None: No OADM	None: No OADM	None: No OADM	2.2 dB
(Typical Optical Loss)										
2.4 dB	2.4 dB	14 dB	14 dB	10 dB	3.8 dB	None: No OADM	None: No OADM	None: No OADM	None: No OADM	3.8 dB
(Maximum Optical Loss)										



Optical Insertion Losses

Optical Insertion Loss estimation:

- Example 5 of Return-path link (Loss) calculation that considers the Origin and two intermediate, OADM (client Drop, Add and Pass-Thru) stages – assumes one λ per Drop point.
- Calculates typical and maximum Return-path Losses from furthest (2nd) OADM (client Add/Drop-point) to Origin.
- Given: Origin Multiplexer/De-Multiplexer (CM-4MD6-A) losses (M_O & D_O) plus two OADM points & losses (C, B, E) and (F, G, H) in the optical path. The Remote site (Mux/De-Mux) is ignored for this calculation example.

Table (C-5)

Insertion Loss: Each Mux + De-Mux stage (typically at segment end-points)		Insertion Loss (1st) Drop point	Insertion Loss (1st) Add point	Insertion Loss (1st) Pass-Thru	Acc. Loss at (1st) Drop point	Insertion Loss (2nd) Drop point	Insertion Loss (2nd) Add point	Insertion Loss (2nd) Pass-Thru	Acc. Loss at (2nd) Drop point	Total Loss at start-point Demux w/ one Add (return) stage & one Pass-Thru stage
(M_O & D_O)	(M_R & D_R)	(C)	(B)	(E)	(M_O + C)	(F)	(G)	(H)	(M_O + E + F)	(G + E + D_O)
12 dB	12 dB	10 dB	10 dB	0.5 dB	2.2 dB	10 dB	10 dB	0.5 dB	2.7 dB	2.7 dB
(Typical Optical Loss)										
2.4 dB	2.4 dB	14 dB	14 dB	10 dB	3.8 dB	14 dB	14 dB	10 dB	4.8 dB	4.8 dB
(Maximum Optical Loss)										

Diagram for Calculation (5)